Title: Porro Prism Finishing

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Porro Prism Finishing

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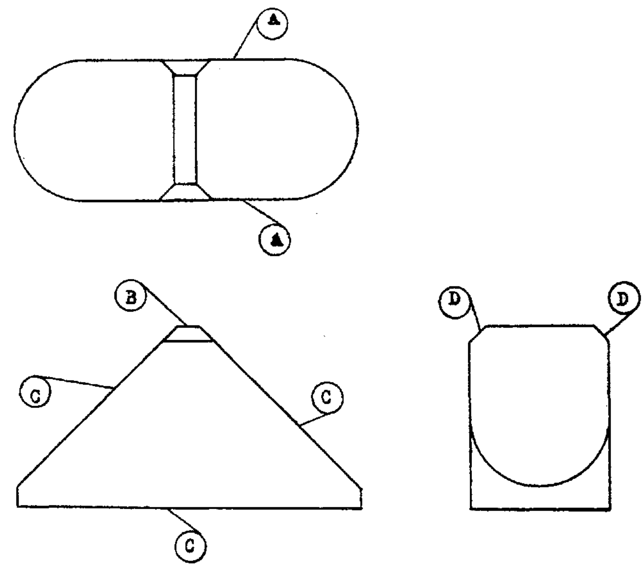
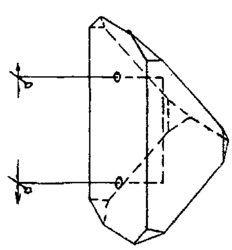


Surfaces of a Porro Prism. (A) parallel sides; (B) topped surface; (C) optical surface; and (D) beveled corner.

What is the optical equivalent of a precision mirror? When light is reflected from a mirror it is changed so that right becomes left while top is not inter-changed with bottom. The effect is the same as is observed when viewing a photographic negative. The relative right and left positions are changed when the negative is turned so that we are looking at the reverse side, but the vertical relationship is the same. In optical systems this same purpose is accomplished with the aid of a porro prism.

A porro prism is of right triangular cross section and usually has a width equal to about one-half the hypotenuse of the right triangle. To be of any optical value the prism must be finished in a manner that will make it, if viewed in cross section, an isosceles right triangle. The right angle of the triangle must be within 30 minutes of arc if the prism is to be used in a pre-



Optical effect of a Porro Prism.

cision instrument. All surfaces of the prism are finished during the processing, but only the sides of the right triangle are given an optical polishing. When finished, these surfaces have a true lens appearance while all the other surfaces look very much like ground glass.

Porro prisms are made from optical glass which has been cast or molded to approximately the shape of the finished prism, but the casting is made slightly larger than the finished optic to allow for finishing of the faces. When the glass is taken from the mold it is very rough and irregular. All roughness and surface imperfections must be removed in the manufacture. If any air bubbles or other inclusions are found in the molding, the piece is unfit for use and must be remolded.

The first step in finishing the prism is the milling of the long face. The rough casting is clamped in a vee-block to place it in the proper position for the facing. The whole fixture is then passed under a high speed grinding wheel which mills the face. The wheels which are used for this and other optical milling operations are diamond impregnated wheels. Small diamond chips and diamond dust are bonded together with a resin compound and shaped into wheel form.

When the long face has been finish-milled, the blank is clamped in a paralleling machine where it is passed between two parallel wheels which face the parallel sides. Since no further work is done on these surfaces, the work must be very well done to present an appearance of good workmanship.

From the paralleling machine the prism goes to the generators where the three optical surfaces are milled. In this machine the prism is held firmly on the two parallel sides and accurately indexed so that each surface is milled at the correct angle with the other surfaces. If the work is well done on the generator, much time is saved in the polishing of the surfaces, since no time will be spent in truing up the face.

In order to permit an accurate location of the prism in the optical instrument at final assembly, the ends of the prism are radiused to an accuracy of plus or minus .0005 inches. The radius is automatically done in a machine equipped with a diamond wheel. If the rounding is incorrectly or inaccurately done the prism cannot be set up in proper position in the instrument and is worthless.

To prevent chipping of the surfaces and to remove the hazard of sharp edges on the finished prism, all edges are beveled, or chamfered, and the sharp angle at the top is removing in the "topping" operation. As a part of the same operation, the two corners at the apex of the prism are removed. With this step the milling is finished and the blank is "blocked" in preparation for grinding.

A circular metal plate, about 15 inches in diameter and perfectly flat, is coated with a thin layer of oil or grease, and the prism is pressed into this grease which holds it in place for the next step. When pressed into the grease, the prism is turned so that the surface to be ground is placed against the plate. A number of optics are placed on the plate, leaving only enough room between them to allow the bonding material to hold them in place. A brass band is placed around the plate making a shallow plate about 3 inches deep. Melted paraffin is poured around the prisms to a depth of 1/4 inch and allowed to cool. Plaster of Paris is used to fill the remainder of the pan, and while the plaster is still pliable another plate is placed on top of the pan and holes in this plate are filled with plaster which bonds it to the plaster in the pan. This last plate has an adapter to fit the spindle of the grinding machine. The entire unit is set aside to allow the plaster to set firmly before the grinding.

When ready for grinding, the assembly is inverted; the metal band and the flat plate are removed. The adapter plate is fitted to the grinding machine and the layer of paraffin is brushed of. When all the paraffin is removed the flat surfaces of the prisms will stand up about 1/4 inch above the plaster bond. A flat grinding plate is placed on the flat surfaces after they have been coated with emery powder in water. The emery acts as the abrasive while the water serves as a carrier. The grinding is accomplished by revolving the prism plate under the grinding plate.

When the surface has been completely ground and is ready to be polished, the whole prism plate is removed from the grinder and thoroughly washed and cleaned. When dry, the plate is set up on a polishing machine. The polishing is carried on in the same manner as the grinding except that no abrasive is used. Pure water is applied to the prisms to keep them from overheating and to carry off the glass particles as they are removed.

When the polishing is complete, the plaster bond is broken up and all the prisms are sent back to be blocked on another face. The same blocking, grinding and polishing technique is followed for the second and third faces.

When all three faces have been polished the prism is cleaned thoroughly and sent to be inspected. If the work has been well done, the prism will be passed by inspection. The finished optic will then be sent to an assembly station for mounting in an optical instrument. In present day production nearly all prisms are used in binoculars, telescopes, periscopes, range finders and other fire control instruments for army and navy use.

ARMOR PIERCING PROJECTILES

It has been reported for some time that the Army was employing a new type of armor piercing projectile for tank and anti-tank guns and just now are the details being made public. The new projectile which has been so effective in combating the German Panther, Tiger and Royal Tiger tanks obtains its vastly higher armor-piercing ability from two factors: (1) the use of extremely hard and tough tungsten carbide instead of steel for the armor piercing core, and (2) much lighter total weight for the projectile. The latter factor is important since it permits a given gun to fire the projectile with a much higher velocity.

The effectiveness in combat of this new shell is even greater than is indicated by their greater armor piercing ability. This is due to their higher accuracy, traceable in large part to their higher velocity and shorter flight time. With the new projectile, it is possible to hit tanks in motion with much greater ease than formerly, while stationary objectives can be hit with fewer misses even at long ranges. According to reports from the front, German tanks have been stopped with just a single shot at ranges up to 3000 yards.

Actually, the new weapon is a projectile within a projectile. Inside the assembly is a core of the hardest metal made by man—cemented tungsten carbide—weighing several pounds. This core is centered in a housing made mainly of aluminum. The chief function of the outer body is to streamline the shell and permit a smaller diameter armor-piercing core to be fired from a larger bore gun. For the 76 mm. gun, for instance, roughly half the weight is contained in the core, the total projectile weight being around nine pounds, compared with roughly fifteen pounds for conventional steel armor piercing projectiles. As a result, muzzle velocity of the projectile is around 3400 feet per second compared with 2800 feet per second.

The aluminum windshield and body and the

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ARMOR PIERCING PROJECTILES

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steel base of the projectile do not perform any major function in the actual penetration of the armor. The armor piercing ability of the new shell is therefore further increased by having its energy largely concentrated in the smaller diameter tungsten carbide core. The extra hardness of the core prevents its being flattened out when it hits. Specimens recovered show the nose of the carbide core to be virtually unmarked after having passed through several inches of armor plate. After penetration, the core breaks up into lethal pieces, scattering in all directions, inside the enemy tank, often also setting fire to the tank.

It is interesting to note that this metal—tungsten carbide—which helped so much in speeding tank production by enabling the machining of armor plate with far greater ease than is possible with steels is now also being used to destroy enemy tanks.

From the Metro-Goldwyn-Mayer picture MADAME CURIE